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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/941,963	08/28/2001	Sunfei Fang	01P14755 US	7736

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EXAMINER

LEE, HSIEN MING

ART UNIT	PAPER NUMBER
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2823

DATE MAILED: 06/04/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/941,963

Applicant(s)

FANG, SUNFEI

Examiner

Hsien-Ming Lee

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 02 December 2002.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-23 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-23 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 8/28/01 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
- If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
- a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____.
- 4) ☐ Interview Summary (PTO-413) Paper No(s). _____.
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: _____.

DETAILED ACTION

Remarks

1. The 102 rejection to claims 1-23 is withdrawn in response to applicants' response submitted 12/2/02.

Claim Rejections - 35 USC § 103

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

3. Claims 1-23 are rejected under 35 U.S.C. 103(a) as being unpatentable over Chooi et al. (US 6,284,657) in view of applicants admitted prior art (hereinafter referred as "AAPA") and Yi et al. (US 5,900,163).

In re claims 1-3,7, 10-12, 15, Chooi et al. teach the claimed method of cleaning a hole 22/24 as shown in Fig. 1-13 and related text in an organic inter-level dielectric (ILD) 14 and 18 (e.g. fluorinated polymer, col.5, lines 33-44), the hole 22/24 having sidewalls and a bottom, the organic ILD 14 and 18 disposed on a semiconductor substrate 10, the method comprising: forming a plasma over the interconnect structure; performing a radio frequency (RF) plasma etching (with a power of 100~2,00 watts, col.9, lines 48-49) for cleaning the hole 22/24, wherein the plasma comprises a mixture of argon and nitrogen (col. 6, lines 37-43), wherein a first component (argon) acts as physical sputter clean (etch), as evidenced by AAPA; and a second component (nitrogen) acts as ion enhanced organic etch or ion enhanced chemical etch;

and further anisotropically removing organic material from bottom of the hole 22/24 with the chemical etch component (i.e. nitrogen).

Chooi et al do not expressly teach that the argon acts as sputter clean function. One of the ordinary skill in the art, however, would have recognized that the role of argon in the plasma functions as the sputter clean because argon has been widely used as etching gas in physical sputter cleaning practice, as evidenced by AAPA. In addition, Chooi et al. also inherently teach that nitrogen in the plasma functions as ion enhanced organic etch because nitrogen gas in the plasma would convert into ion species under RF power, wherein the ions are for etching purpose.

In re claims 4, 13 and 18, Chooi et al. in view of AAPA teach that the RF sputter clean comprises argon but fail to teach comprising helium. However, helium is art-recognized equivalence to argon in physical sputter cleaning (etching), as evidenced by Yi et al. (col.1, lines 50-53).

Therefore, one of the ordinary skill in the art, at the time the invention was made, would have been motivated to substitute argon of Chooi et al. in view of AAPA with helium of Yi et al. for a reasonable expectation of success because both argon and helium are relatively heavy masses and are good candidates for physical sputtering.

In re claims 5, 6, 8, 14, 20 and 21, Chooi et al. in view of AAPA teach that the RF sputter clean and the organic etch are performed at the same time interval by the same plasma because a singular etching plasma comprising argon and nitrogen is used to treat the sidewall and bottom of the hole, as stated above.

In re claim 9, Chooi et al. in view of AAPA et al. also teach that the hole 22/24 is part of an interconnect structure, wherein a conductive layer 10 is disposed at a bottom of hole 22/24 as

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shown in Fig. 2, wherein the sputter clean removes a surface oxide formed on the conductive layer 10.

In re claims 16, 17, 19, , it would have been obvious to one of the ordinary in the art to recognized that Chooi et al. in view of AAPA, as stated above, also teach the claimed method of forming an interconnect through an organic ILD, the method comprising:

- forming a lower conductive layer 10 on a semiconductor substrate;
- forming the organic ILD 14 and 18 on the lower conductive layer 10;
- etching a hole 22/24 through the organic ILD 14 and 18 down to the lower conductive layer 10 (Fig.2);
- performing an RF sputter clean (using the argon gas) of a bottom of the hole 22/24;
- performing an anisotropic, ion enhanced chemical organic etch of the hole (i.e. using nitrogen gas), wherein the etch is performed at least partially during the RF sputter clean because a singular etching plasma comprising argon and nitrogen is used to treat the sidewall and bottom of the hole 22/24;
- forming a plug 22 in the hole 22/24 (Fig.14); and
- forming an upper conductive layer 24 (via) on the organic ILD 18 and the plug 22 (Fig.14)

In re claim 22, Chooi et al. in view of AAPA also teach forming a lower cap layer 12 on the lower conductive layer 10 before the forming of the organic ILD layer 14 and 18 (Fig.1), and forming an upper cap layer 20 on the organic ILD layer 18 (Fig. 10), wherein the etching of the hole 22/24 further comprises etching through the upper cap layer 20 and the lower cap layer 12 (Fig.11).

In re claim 23, Chooi et al. in view of AAPA also teach forming a liner 26 in the hole 22/24 before forming the plug 22 (Figs. 12-14).

Conclusion

4. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

Burke et al. to US 6,042,929 teach the common subject matters (col. 4, line 65 through col. 5, line 4).


Zhang et al. to US 6,294,458 teach the common subject matters (col. 5, lines 40-62).

Li et al. to US 2003/0024902 teach the common subject matters (paragraph [0032]).

5. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Hsien-Ming Lee whose telephone number is 703-305-7341. The examiner can normally be reached on M-F (9:00 ~ 5:00).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Olik Chaudhuri can be reached on 703-306-2794. The fax phone numbers for the organization where this application or proceeding is assigned are 703-308-7722 for regular communications and 703-308-7722 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0956.

Hsien-Ming Lee 
Examiner
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May 30, 2003